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TITLE : THE TELEPRINTER PUNCHED CARD COMPUTER UNIT

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A punched card computer unit equipped with teleprinters started functioning at the beginning of 1958. It is the first punched card computer unit of this kind not only in Czechoslovakia but in Central Europe as well. The author of the following paper, František Kletečka not only put forward a theory of it, but also organized and realized it and has thus pioneered a new way and form of mechanization.

The Editor

The organization of the TEPLOTECHNA national Corporation

Introducing my paper I would like to describe in a nutshell the organization of the TEPLOTECHNA national corporation. This organization is, however, not of a decisive character in establishing punched card computer units of this kind as similar departments may be established within any enterprise, company or office whatever their organizational problems may be.

The TEPLOTECHNA national corporation is an enterprise dealing with the construction and assembly of thermic systems all over Czechoslovakia and abroad. Its central management has Prague for its seat while its branches are spread all over the country being situated in regional towns - they are called construction offices. Whereas the branches, economically independent, control their construction activity for themselves, the central management finances and controls its branches as a whole. Each branch is closely specialized in its own work within the framework of the regional industrial building.

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So, for instance, the Ostrava branch carries out the building of glass industry thermal aggregates, etc. Both the central management and the branches are interconnected by a teleprinter system. It was just this system which made me think that the existing computer of the Prague management could be controlled by means of the teleprinter direct from the branches. In this way one would make full use of the central punched card computer, and, what more, there would be a possibility of a fast and operative processing of the administration as a whole, including branches spread all over the country, by means of efficacious punched card machines. The administrative work proper of the central management is simultaneously punched during routine work in punched tape which is thus obtained as a by-product without extra work, and is handed over to the punched card department at once.

How the Punched Card Computer is Technically Equipped

The entire teleprinter network is, first of all, one of the basic elements of the technical equipment even if it actually remains the property of the Ministry of Communications. A teleprinter network without any breakdown remains, of course, one of the ideal conditions which help the punched card computer to full success. There are still many people who disbelieve the teleprinter network, and their disbelief is often justified. When we were undertaking a long-term survey of the entire teleprinter network last year, we really met rather a considerable number of the shortcomings in the teleprinter technique. We finally gathered all the reasons of breakdowns and divided them into two groups. The first group comprised cases of interference caused by people either directly by mistakes or because of bad, nonexpert service. The other group, slightly smaller in extent, contained cases resulting from the function of the electro-mechanical equipment itself.

The cases of the first group could in general be easily removed. It sufficed to secure the local power supply so that the operators could have the necessary working quiet milieu, to complete the writing codes by error clearing commands, and, finally, to have the assistants trained by experts.

The problems of the second group were, however, slightly more difficult. Here it was necessary to take the following measures:

To use, first of all, teleprinters of the same make in the entire teleprinter network and bring them into harmony. It was necessary to make use of night connections, partly because of the fact that the teleprinter network is not, in such

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heavy use / smaller probability of breakdowns/ during the night, partly because of cheaper night rates.

To exclude manual exchanges and replace them with automatic ones; to use only automatic punched tape transmitters of the best quality; to pay careful attention to the timely exchange of repeaters; not to use, as a matter of principle, overhead lines and finally to exchange old cables causing the greatest number of faults.

Another technical equipment consists of the teleprinters proper. It is, as a matter of principle, necessary to use only page machines with built-in receiving key punches and longdistance line switches. The teleprinters can be supplied either direct from the mains or from a local power supply.

Quite a necessary additional equipment is represented by automatic punched tape transmitters used not only in the actual teleprinter system but also for reading and checking the punched tape, its cutting and providing new copies of it as well.

All devices mentioned above and the technical equipment are provided by the Ministry of Telecommunications in a similar way as an installation of the telephone line.

Owing to its technical equipment the punched tape reader is synchronized with the key punch which is actually a valuable product of the ARITMA national corporation. The relays of the reader enable the punched tape to be read according to the requirements of the overall design. This reader simultaneously controls the key punch during the reading of punched tape. The uncoiling of the punched tape is carried out direct from the inside of the coil while the reader is adapted for reading the punched tape either from the beginning or from the end.

Additional machine equipment is the same as that currently used in normal punched card computers.

Organization and Processing

The organization of work /carried out by the so-called "flowing work method" / including individual work processes adapted to the conditions of the teleprinter communication was worked out by the TEPLOTECHNA national corporation.

When doing so attention was paid to the possibility of removing eventual breakdowns, which usually occur during the teleprinter communication, and the most acceptable method of installing the entire teleprinter network was tested and secured at the same time.

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The technical requirements for the adaptation of the reading device, suggested by the management, were realized by the ARITMA national corporation.

The fact that the punched tape is obtained as a by-product principally changes the entire process of individual work operations, and, in principle, removes the duplex work of administrative kind excluding in addition most administrative operations by fully replacing them.

By way of example I have quoted here several operations carried out formerly and related to invoices:

1. operation: entering the invoice in the mail log,
2. operation: taking over the mail administratively,
3. operation: entering the invoices in the invoice log,
4. operation: specification of invoices according to their destination to individual enterprises and departments,
5. operation: taking over these invoices in the finance accounting department,
6. operation: actual entering invoices in the ledgers in the accounting office.

Most operations mentioned above are either replaced or mechanized by using the punched tape as far as this has been obtained as a by-product during the first operation.

The punched tape may be used to a much greater extent in cases where it is obtained as a by-product in non-recurring work and then regularly used as a constantly stored /"punched/ information; such a case may, for instance, occur when the monthly plan of production costs is specified to individual departments assuming that eventual changes of the plan will be completed in individual monthly periods.

The punched tape can similarly be used to advantage in setting up the output and material standards where the filing of these "standards recorded" on the punched tape can serve to automatically worked-out preliminary calculations of sales and production, production targets, consumption limits of material, the specification of the use of production working parts and other direct costs. In such cases the punched tape substitutes the work of a number of employees.

It must, however, be mentioned here that with all these operations, during which the punched tape is obtained as a

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by-product, one can arbitrarily alternate both the words and figures and punch either in the punched tape as the reader of the punched tape reacts only to digital data. This advantage can be used in further handing over the information from the same tape punched to all other places, especially the remotest ones, where the coding technique would cause certain difficulties.

The punched tape is handed over to the punched card computer unit equipped with teleprinters daily either by mail, if there is no need to process it immediately, or by the tele-printer system if the sender wants to know the processed results as soon as the following morning.

As for the codes themselves, they are determined in the punching technique by a strict organization following from these principles:

i/ the order of grouping the data in the punched tape must be accurately determined,

ii/ the sender must be allowed a certain possibility of economic operations,

iii/ an intermediate between the methods of using one card and that of two cards should be used,

iv/ the possibility of flexible control of the documents should be secured,

v/ a desirable visual and preventive control as well as the possibility of mechanizing it should be facilitated.

The punched tape, obtained as a by-product, serves our enterprise to fulfil three main tasks as follows:

i/ it renders the communication technique automatic,

ii/ it renders the punching of cards automatic,

iii/ it renders the repeated operations automatic by durably punching the work programme and filing it.

Punched Tape System Check

The check proper of the entire routine work controlled by the punched tape is one of the most important elements accompanying the punched tape on its course from the beginning till the end which is represented by the check tabulation summary:

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i/ the first check is secured during the course of obtaining the punched tape from routine operations already, that is, by checking the written text. The errors ascertained during this routine work are removed by punching the command to clear the erroneous text direct in the punched tape;

ii/ the second check is carried out after the part of the work has been finished by comparing it with the written text. The errors found out in this check are removed by additional corrections punched in the tape.

Either check secures that no error, caused by human interference, can get into the communication system;

iii/ the third check of the contents of the punched tape is an independent one, and is carried out either during the automatic transmission in case of making use of the communication system or during the automatic replay of the tape if this has been sent by mail. Both the automatic transmitting and replay is done in the RFT page teleprinter which carries out the transcription of the punched contents into a written text, makes a copy of the text while a special counter carries out a zero check of the correctness of the numerical data;

iv/ the fourth check is then carried out in the teleprinter punched card computer which obtains the written text either from the teleprinter during the transmitting or as enclosed accompanying report in case the tape has been sent by mail. The latter check of the written text is carried out only visually and an additional report is required for the errors ascertained, while the check of the written text received by means of the telecommunication system is carried out during the transmission of the report under the same conditions. Eventual errors ascertained during the check are removed by asking for a repeated transmission of the erroneous parts;

v/ the fifth check is that of punched cards obtained from the punched tape. The vertical indication columns are controlled at random while the identical indication fields are viewed against light. In either case errors incurred in punching, may be found. If this is the case, the error is removed in the key punch by additional punching of the erroneous card, or, according to the kind of error, by a new punching making use of the original punched tape;;

vi/ the sixth and last check is carried out directly in the tabulating machine. The checking operator has at her disposal

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the report with the text obtained by way of teleprinter which she compares with the control tabulation summary.

If the service and maintenance of the equipment are good and thorough, the number of errors is, generally, a small one.

The Advantages of the Teleprinter Punched Card Computer as compared with the Normal Punched Card Computer

It is, above all, an important problem of an automatic machine processing of punched cards which results, first, in saving an operator and her painstaking work, and, second, in increased speed of punching the cards.

One can further save a duplex punching in the verifiers which results in savings both of operators and machines.

The errors and mistakes which occur as a result of illegibility of primary documents from which the operator of the punched card department executes the punching, are excluded here, and only the customer is responsible for the correct punching of data in the punched tape.

The transport of primary documents to the punched card computer unit and the administrative work connected with it are necessary no longer.

The creation of peak loads in punched card computer units is reduced to minimum because of obtaining the punched cards in routine work.

The possibility of an easy contact and resulting co-operation with customers—even the remotest ones.

There are no longer difficulties in assigning the tasks of work made by hand in the punched card computer unit while this becomes more operative for the customer as he gets the results, processed in the punched card computer unit, without any delay.

The possibility of an efficacious and flexible production control, even locally remotest, backed by statistics and analyses processed in tabulation summaries during a short time period.

The teleprinter punched card computer unit can enlarge the extent of its jobs much more easily just because of the work schedules, recorded in the punched tape in advance and stocked in its files.

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An Outlook on Communication

An organization of work as we have introduced in the teleprinter machine processing, will have no difficulties in passing over to the use of magnetic tape, and, maybe even more valuable, to wireless teletypewriter communication which is already being used abroad even if for other purposes only. Such a wireless teletypewriter punched card computer unit could easily process the administrative work of, for instance, ocean-going liners.

(To be continued)

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EXPERIENCE WITH THE PUNCHED TAPE SYSTEM

František Kletočka

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Continued from: The Teletypewriter Punched Card Computer Unit

While the punched tape was gradually securing its mission irrespective of the number of its adversaries even outside the enterprise, its development was proceeding in all three basic sections:

- i/ in the teletypewriter punched card computer unit,
- ii/ in the telecommunications,
- iii/ in technical and administrative jobs.

It is necessary to stress that these developments complete mutually in all three sections, and did not even stop before the intricate structure of the national enterprise determined by its work contents. Only for information about the difficulty of organizing the structure of the national corporation we have enclosed a sketch of the work extent on the map of Czechoslovakia, refer to Fig.1. The lines illustrate the direction of working places, the circles give the location of construction offices while the square represents the central location where the punched tape is processed, that is, the proper seat of the teletypewriter punched card computer unit. The lines passing the frontier of Czechoslovakia represent the jobs carried out abroad.

When considering the practical use within the framework of the entire organization, developments have taken place along several lines, some of them have already been realized, while others appear to be both necessary and desirable. Some of them even seem to be too fantastic.

A. The Teletypewriter Punched Card Computer Unit

This unit, mostly equipped with machines made by the ARITMA national corporation, has, at its beginning, become the basic part of the "large" mechanization. Its arrangement is decisive for success in the endeavour as its capacity has so far influenced the structure of the two other parts, that is, the telecommunication system, and the technical and administrative work resulting in punched tape. Only after all these three parts have been improved, the design of jobs gradually in all three parts was started, that is, the origin of the punched tape, its transporting by the telecommunication system and its processing in efficacious ARITMA machines.

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1/ The present work consists of:

- the page teleprinter for the reception of information from outside,
- the ARITMA reading device, and
- the ARITMA key punch.

This mutual connection, which has only been carried out by direct routing the punched tape from the teleprinter to the reading device (see Fig.3) resulted in punching the cards already during the reception of information. The connection has replaced the former input control, the punching of cards by hand, and the verification of punched cards made by hand in another way controlled only by one operator.

ii/ The aggregate of several punching machines

We mean an aggregate of at least three key punches controlled by the same number of ARITMA reading devices controlled from one control desk only. This aggregate enables to increase the speed of punching attended by one operator only. In so far as it is connected with the communication system, it enables to make use of time breaks of the telecommunication system influenced by the duration of the reception of information to work out the punched tape inside the unit. Making use of large reels with the punched tape makes the work easier for the operator attending the aggregate of several machines as the large reels reduce the movements which more often occur when attending the functional keys.

iii/ The play-back of daily results

The repeated punching of daily tabulation results /totals and grand totals/ in the punched tape and their playing back to customers is very suitable when use is made of the ASTRA adding machine connected with the ARITMA punch. Even the simultaneous control of writing down the results through the nought balance has been attained when using these machines. This work would be replaced by such a construction of a tabulating machine that would process the punched tape with teleprinter codes as a second output product.

iv/ The room for playing the punched tape

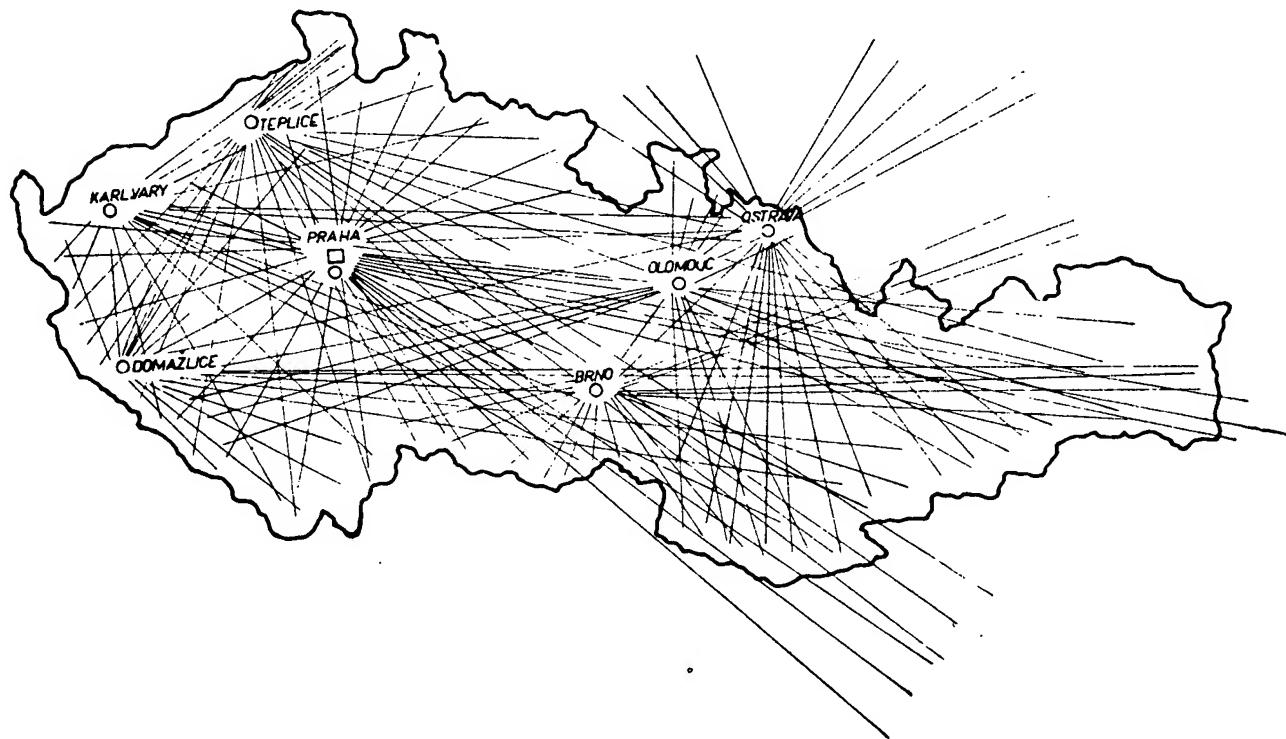
As the use of the punched tape has proved to be necessary on the spot of its origin already with regard both to the checks and different possibilities of application, it is also necessary for the teleprinter punched card to instal an independent room for replaying the punched tape for the purpose of working out the filed punched tapes in which the entire work

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programmes, repeated all time, are permanently punched. It is easy to equip such a room for replaying if the present page teleprinters with tape punches are used in connection with the automatic play-back transmitters. The coding automatic machine also enables to replay the permanent programmes from several points of view.

v/ The automatic work line in the teleprinter punched card computer unit

This line can be foreseen in the near future as it is no problem to complete the end of the teleprinted information with the functional programme of part commands to perform the sorting, punching in the calculating punch, and tabulating. It will be necessary to make use of remote control of functional keys and to fill up the desirable distance between the individual machines with automatic conveyor belts to transport punched cards and punched tapes. Such an automatic line should, however, be completed by alphabetic numerical machines exclusively.



Pig.1

Work extent of the enterprise

B: Teletypewriter communication

This part of mechanization was regarded undesirable and unnecessarily expensive by many people. They thought that it could serve for the transportation of the punched tape only, which can be substituted by mail delivery to advantage. It was, however, proved in practice that not only the speed of the transport is very often more desirable but also teletypewriter technique cannot be dispensed with. That is to say, it enables to make use of different possibilities of originating the punched tape most economically. All machines of electromechanization, which are used to originate the punched tape as a by-product, must be equipped with functional keys of all teletypewriter symbols.

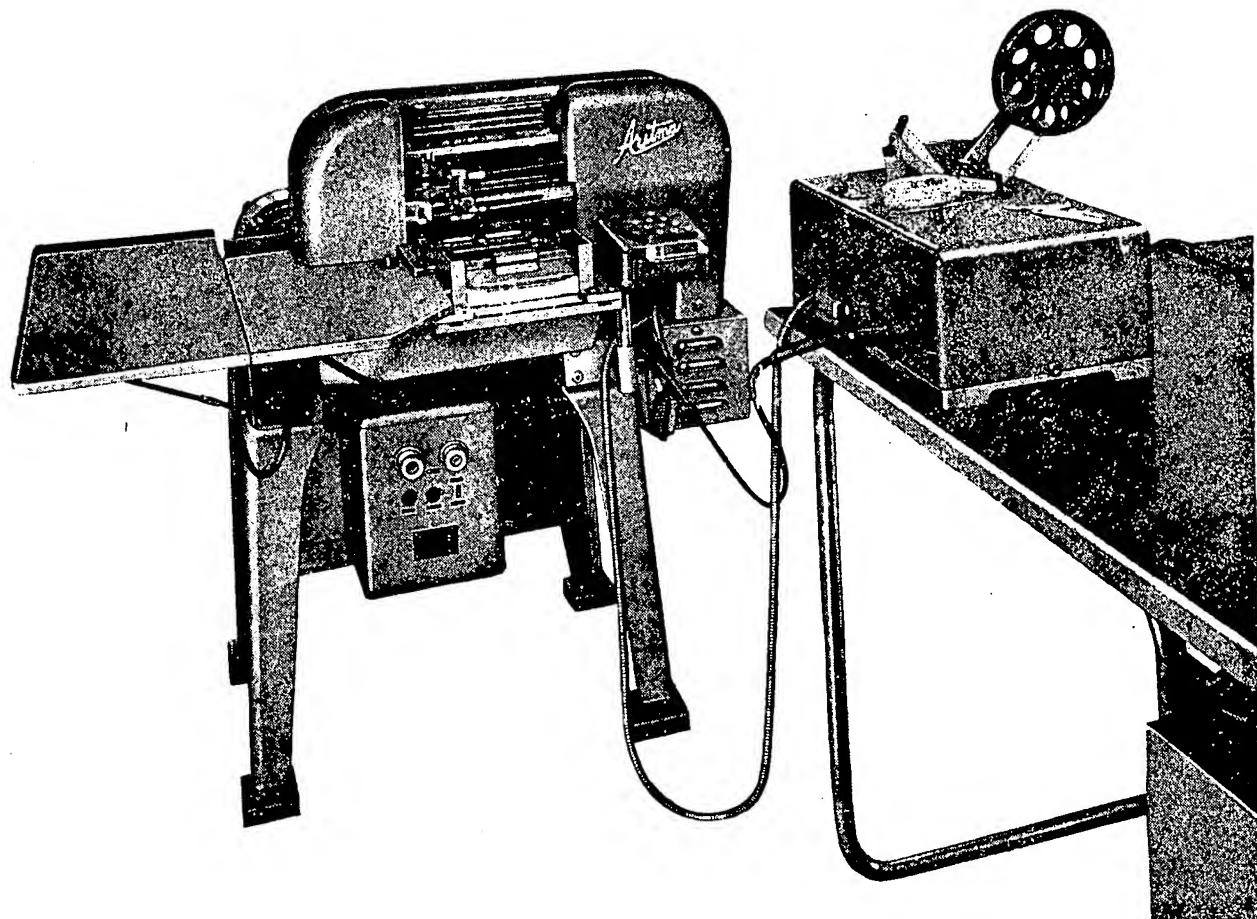


Fig. 2

Punched tape reader combined with a tape punch .

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i/ Replaying the punched tape

This working process appeared to be absolutely necessary especially in connection with the writing device. Partly it enables to carry out a visual check of the punched tape, partly it offers the possibility of cutting, cutting out, and combining, and finally facilitating use of matrix tape for permanently repeated information and indication.

ii/ Following counters in the telecommunication technique

This device, with which one only counts in the entire system so far, has been set up as a development task to be carried out by the ASTRA national corporation. It will render automatic a part of the visual control as far as it performs the control of columns containing the sums of values under the form of the nought check. The considerable speed of incoming information, transmitted by means of automatic transmitters, hinders visual checks so far. The following counters will, however, be a very important aid also in the transmitting departments.

iii/Completing the international alphabet No 2

In order that the punched tape could control the provisional system of the entire present design of ours, the original international alphabet No 2 had to be completed by further symbols of commands as used in our closed circuits.

A reel of 250 meters of punched tape weighs 0,4 kgs approximately and contains 100 000 characters; postal delivery as a registered letter costs 2,40 Kčs.

The situation of symbols of the international alphabet No 2 proves that it will in the future be necessary to bear in mind the selection of group couplings of symbols. The changes of coded contents of daily teletypewriter reports, which very often occur and cannot be removed, do not permit to make eventual use of devices in punching machines for the automatic control of certain functional commands. It will, therefore, be necessary for the punched tape, even with more channels, to take over these commands as far as the device could not be controlled by it directly.

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The Technical and Administrative Work

This sector of mechanization has actually originated the punched tape. It is equipped with machines of electro-mechanization in which the punches of the tape are either built-in or connected with by synchronization. The basis of the work designed for this part of mechanization had been determined by the national corporation before the entire system was introduced already, and the employees have been instructed on the design through a textbook. In this way the flowing method of work organization has so far become a common symbol of all kinds of work for it follows from principles strictly kept.

It was, however, necessary to start developing the work of this part only gradually with respect to a gradual training of employees and the gradual completing of the electro-mechanized machines with punched tape. That is why five successive stages were to be carried out:

i/ The punched tape as a main product

This stage is considered to be necessary as it should acquaint the employees with the punched tape and train them in the entire punched tape system. The average punched tape is good for about three months. The punched tape obtained as a main product of the technical and administrative work did not seem to bring forth visible savings. The time saved in former work by hand in setting up results had to be spent in punching the tape. On the other hand, the teleprinter punched tape card computer unit could manage the automatic punching of cards, improve the input control, and exclude the verification of card punching done by hand. Anyway it is not recommended to make this stage too long as this could serve as an opportunity for adversaries of the punched tape.

ii/ The punched tape as a by-product

This stage is actually economic in itself as it is no longer necessary to spend additional working time in obtaining the punched tape. The punched tape is obtained during the routine work of setting up or liquidating the primary documents. As it is obtained at the setting up of primary documents already, it renders automatic the entire working process of the former working out by hand the primary documents even in this stage of the technical and administrative work. Here the adversaries of the system have the last opportunity in the fact that the form of primary documents in the coded summary is unintelligible to other employees.

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iii/ The punched tape as a permanently recorded working programme

This stage of further development in the use of the punched tape therefore substitutes for the entire working processes which are usually repeated. It is first of all the recording of work and material standards by means of which calculations and material limits may be set up to advantage. A similar case occurs with the planning of production costs.

If one considers the fact that the punched tape has been obtained as a by-product, then its many-sided use is definitely an additional contribution to the entire system.

iv/The punched tape as a means of coding

This further development stage removes the last opportunity to complain of unintelligibility of primary documents as mentioned under ii/. One commonly works here with two punched tapes one of which is a "live" one, that is a tape containing the changeable indication of the primary document, while the other is "dead", that is, the matrix tape containing an unchangeable code indication.

The live punched tape is, therefore, obtained as a by-product during filling in the original primary documents so that the form of the original primary documents does not undergo any changes. The matrix tape is obtained during the development stage quoted under ii/. The mutual cooperation of these two tapes is either carried out by hand /the matrix tape serves only in the direct contact at originating the live tape /or automatically/ the live tape originates as an independent item of the matrix tape/, and only the code automatic device selects from these two tapes, gradually and in a chosen sequence, the data desired for the final adjustment of the punched tape system. The advantage of an automatically set up system of two punched cards manifests itself here already in practice which enables us to pass on to the last stage of development.

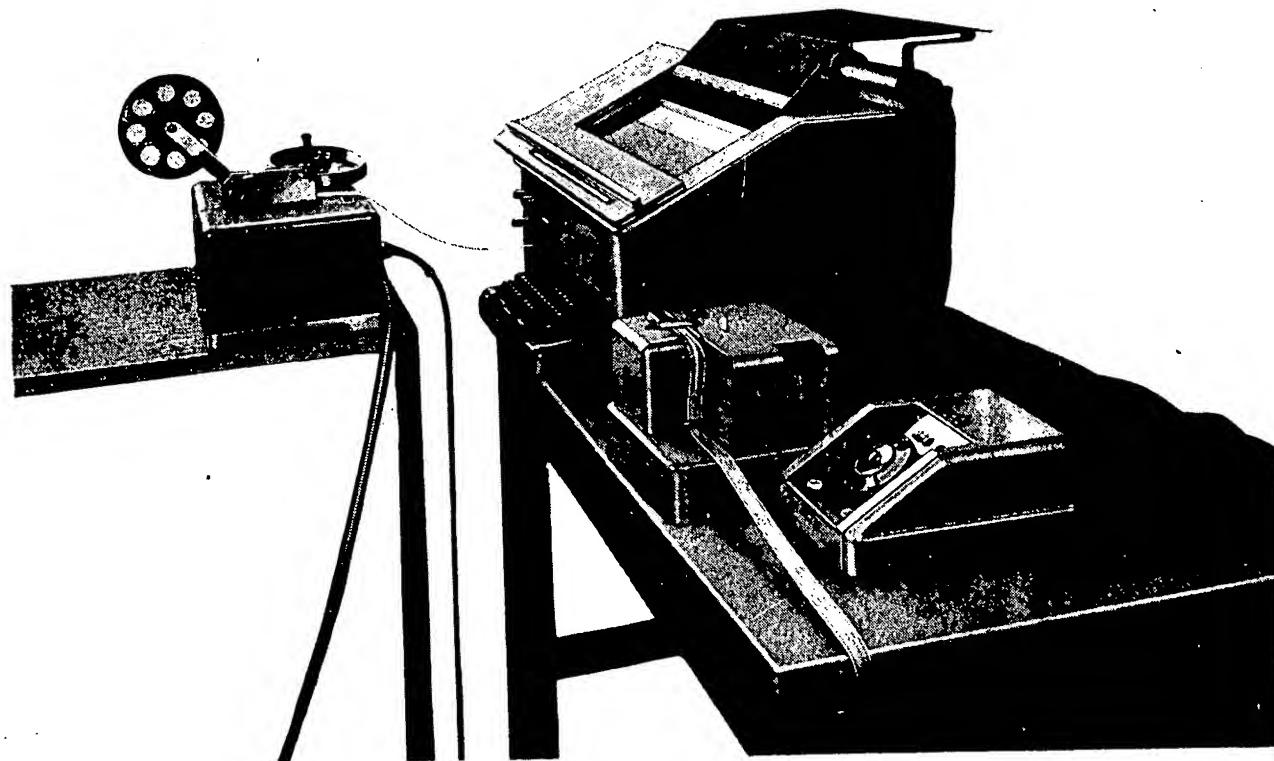
v/ The punched tape as a means of intercommunication

This stage of development is so far the last one, and is considered to be the most advantageous. That is to say, that the individual organisations mutually interchange the live tapes which thus serve both organisations. In case of TEPLITECHNIKA national corporation it is for the time being the contact with individual branches in the sphere of lending different working parts of machines and that of invoices where the live tape follows the output of workrooms while in the enterprise management the same tape follows

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the customers' contacts. There will certainly be no obstacle for the tape to be of use also in finance where the economic organisation gets the live punched tape instead of the bank statement with its enclosures; the tape will thus serve both the bank and the organization.



Direct routing of the punched tape from teleprinter to tape reader.

Fig. 3

All through the year 1958 the evaluation of individual branches and the teleprinter punched card computer unit was kept only via cable, and punching of cards by hand was not carried out at all.

Meanwhile the following indexes relating to punched tape in the teleprinter punched card department per one shift and one set of the ARITMA machines have been obtained.

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The set of machines in the teleprinter punched card computer unit consists of one tabulating machine, one sorter, two reading devices connected with two key punches of cards, and one receiving teleprinter.

1. the total number of operators per one set 4
2. the number of key punches per one set /including the reading device/ 2
3. the number of cards punched per set per month /it must be kept in mind that the set has only two punches/ 48,200
4. the number of cards punched per one key punch per month /here again it must however be borne in mind that the punched tape contains about 80 per cent of punching fields which are not punched as, for instance, the information agreed upon and accompanying the punching codes and commands/ 23,800
5. the number of passages of current meters of the punched tape through one reading device per month /100 impulses = 254 mm/ 7,617
6. the number of consumed reels of punched tape per one reading device per month /the reel contains 300 meters/ 25,4
7. the number of standard hours per one reading device per month /7 impulses = 1 second/ 119
8. the average cost of setting up one punched card:
 - i/ the pay of the operator attending the telecommunication equipment and the reading device 1,400,-
 - ii/ the punched tape /50,8 pieces per 6,20/ 314,96
 - iii/ punched cards /47,600 per 0,02/ 952,-
 - iv/ the teleprinter rolls /50 pieces per 2,40/ 120,-
 - v/ the repairs of reading devices and key punches 240,-
 - vi/ the share of common overhead costs per one unit of pay /105 per cent/ 1,470,-
 total 4,896,96
- that is, the costs per one punched card 0,09

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9. The average of transfer pulses per one error caused by additional pulses /they are visually perceptible because of their making the codes longer/. Out of 2,470,000 transfer pulses 255 errors have been recorded while the errors caused by confused impulses were not ascertained 9,686

The results reached during several years of working are certainly not final. The difference is in the development of the punched tape system in the sphere of technical and administrative work, and the exploitation of all possible ways of obtaining punched tape as a by-product as well, especially in the first stages of the entire working process. In this way all possible double work will be dispensed with. The trend of the work so far processed will, therefore, mainly aim at the technical work where the computation technique is demanded to be supplied without delay while the complex accounting and statistical work will be abandoned gradually.

The entire system has been tested in practice and appears to hold advantages and promise over for existing punched card computer units.